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THE INTERACTION BETWEEN INFLATION AND MONETARY AGGREGATES IN ISRAEL

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I. INTRODUCTION AND MAIN FINDINGS

Most attempts—in this country and abroad—to explain the accelerated inflation of the last decade take account of the effect of monetary factors, and there is in fact a variety of empirical evidence which shows that their role is a dominant one.

The monetary developments experienced by Israel in recent years (some of them resulting from the 1977 liberalization of foreign currency) and its high inflation (up to three digits) provide an excellent quasi-laboratory environment for research into the interactions between monetary variables and the rate of inflation—research that can contribute to our understanding and help the monetary authorities to evaluate their policies. Such a study should be based on a structural model of the monetary sector, a model that contains behavioral equations and the budget contraints of economic agents. To the best of our knowledge, no such analytical model has yet been completed. Indeed, its construction depends on the answer to several empirical questions; for example, should one assume price rigidity in the long, short, or medium run? Do changes in the quantity of money affect prices? And if so, what is the mechanism through which the effect works, and what are the lags involved? Since these are still open questions, we believe that it is better at this stage to examine the facts without forcing them into a specific structural model; in this way we hope to reveal the empirical regularities of the connection between money and inflation, and to use them in the construction of an appropriate model.[1]

The aim of the present study is, therefore, to examine the relationship between monetary variables and inflation in recent years, using econometric time-series tools. The emphasis is on forecasting, that is, on the contribution of the monetary variables to the statistical significance of the explanation of inflationary developments, and vice versa. In order to explore these problems we use tests of causality; in interpreting the results, the correct statistical meaning of causality as defined in what follows should be borne in mind.

In the course of this study we examined a large number of monetary aggregates.

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[1] For an extensive discussion of this approach, see Sims (1980).

The findings relate to the period January 1972–September 1980. We use monthly and quarterly data for 1972–80 and, for the discussion of the money supply, annual data for 1954–79. The monthly data serve to examine short-term interactions; the quarterly data serve for the medium run, and the annual data for the long run.

From the outset, the monthly tests showed that the relationships have not been stable—a natural break can be seen following the 1977 reform of the foreign-currency regime, and the sample is therefore divided at this point. The quarterly and annual data, however, contain too few observations to make it possible to split the period.

The monthly data were run twice—once seasonally adjusted and once unadjusted. It turned out that the results were not very sensitive to the seasonal adjustment.

The following variables enter the monthly and quarterly tests:

M_1 = Means of payment
$M_2 = M_1$ + negotiable certificates of deposit + time deposits
$M_3 = M_2$ + current resident deposits (foreign currency) + resident time deposits (foreign currency)
$M_4 = M_3$ + bonds held by the public
C_0 = total bank credit
B_1 = money base narrowly defined
G_0 = government and Jewish Agency injection
G_1 = injection stemming from government demand surplus.

The first six variables are stocks, and we therefore use their rate of change; the remaining two are flows, and their period values were used.

Table 1 presents the annual rate of change of the variables. As can be seen, the proportion of those containing linked elements (M_3 and M_4) has risen at the expense of the unlinked aggregates.

Table 1
THE MONETARY AGGREGATES
(percent change over the preceding year)[a]

	M_1	M_2	M_3	M_4	C_0	B_1	CPI
1973	32.30	18.54	18.46	50.06	32.14	25.96	26.40
1974	17.99	10.71	13.42	43.11	70.80	9.30	56.18
1975	21.69	15.30	18.69	16.85	30.20	4.80	23.50
1976	27.07	24.28	33.02	19.09	38.70	46.00	38.00
1977	38.78	36.00	64.18	44.86	85.39	51.60	42.50
1978	45.10	38.50	100.10	70.78	55.26	27.29	40.10
1979	30.51	31.00	84.10	92.82	115.30	12.88	111.40
1980	97.74	113.18	134.10	146.97	133.86	98.43	132.94

[a] Calculated from end-year figures (December–December).

The short-run test (monthly data) indicates that the causal relationships are not constant. Before the 1977 reform, M_1 affects prices, as does credit, though somewhat less strongly; there is no converse effect of prices on money. After 1977, on the other hand, the effect of money on prices weakens, while the effect of prices on money is dominant. A possible explanation of this pattern is connected with dollarization and with the increase in the weight of the linked elements in the public's portfolio of liquid assets. It is not yet possible to check whether the quarterly or annual data show a similar reversal of causality, since the series are not yet long enough.

The credit variable, which is to a large extent under the control of the central bank, turns up in several of the equations as the variable whose effect on inflation has the highest significance after the foreign-currency reform. This effect has a lag of several months and disappears in the medium run. A thorough study of how credit fits into the inflationary process and the country's macroeconomic system would therefore seem to be a promising topic for future research.

In the medium run (quarterly data) there is no significant effect of money on inflation, a result that to a large extent contradicts the common opinion that an increase in the quantity of money (however defined) accelerates inflation in the medium run. On the other hand, it was found that while prices do not affect the linked aggregates (M_3 and M_4), they have a significant effect on the others. A possible explanation is that the price increase instantaneously raises the value of linked assets, a relationship which is evident in the monthly data for the post-reform period. The public's portfolio is unbalanced and unlinked assets are adjusted in response. Other explanations are of course possible.

In the long run, money affects prices with a two-year lag, and monetary changes evidently do affect inflation with such a lag. The reverse causality was also significant—price increases entail changes in the quantity of money.

Our results were in several respects similar to those obtained for other countries. Thus the absence of any strong short or medium run effect of money on prices and its presence in the annual data is a pattern found also in the United States. The finding on the effect of prices on money is consistent with those of Kleiman and Ophir (1972) as well as with some studies of hyperinflation (Sargent and Wallace, 1973, and Frenkel, 1977).

To sum up the principal findings (see Table 2): (a) The monetary aggregates do not for the most part affect inflation in the short and medium run, the exception being credit (C_0) and M_4. (b) In the long run, M_1 affects inflation with a two-year lag. (c) As regards the effect of inflation on the monetary aggregates, we find that it affects linked assets (M_3, M_4) in the short run; in the medium run, it affects the unlinked but not the linked variables. (d) In the long run, inflation again affects M_1.

Section 2 discusses the methodology of causality tests; Section 3 contains a brief survey of earlier work on related topics, in Israel and abroad. The findings are in Section 4 (the tables are in the appendix), and Section 5 concludes the paper.

Table 2

SUMMARY OF FINDINGS[a]

Long run		Medium run		Short run	
$M \rightarrow P$	$P \rightarrow M$	$M \rightarrow P$	$P \rightarrow M$	$M \rightarrow P$	$P \rightarrow M$
$M_1 \rightarrow P$	$P \rightarrow M_1$		$P \rightarrow M_1$	Pre-reform	
			$P \rightarrow M_2$	$M_4 \rightarrow P$	
			$P \rightarrow G_0$	$C_0 \stackrel{\cdot}{\rightarrow} P$	
			$P \rightarrow G_1$	Post-reform	
			$P \stackrel{\cdot}{\rightarrow} B_1$	$M_4 \stackrel{\cdot}{\rightarrow} P$	$P \rightarrow M_3$
			$P \stackrel{\cdot}{\rightarrow} C_0$	$C_0 \stackrel{\cdot}{\rightarrow} P$	$P \rightarrow M_4$
					$P \stackrel{\cdot}{\rightarrow} C_0$

[a] Symbols: M, monetary variable; P, prices; arrows indicate the direction of Granger causality (see below); $\stackrel{\cdot}{\rightarrow}$ indicates that the causal relation was found for some but not all lags.

2. METHODOLOGY

Macroeconomic studies based on time-series data nowadays rest on two general econometric modelling approaches. The first specifies a structural model (such as the Bank of Israel's model) in which economic theory[2] plays a central role in the *a priori* formulation of equations and constraints. The idea here is to accommodate the data within a general theoretical framework.

The second approach is the analysis of time series, in which the data play the central role, both in formulating the equations and in testing constraints. Once the empirical work is complete, the findings are incorporated into a theoretical framework.

This is, of course, a simplified presentation of the two approaches, which interact in empirical work; as Granger and Newbold (1977, p. 7) put it, "it is almost a tautology to say that the optimum approach should probably involve the best features of each." The two approaches must therefore be viewed as complements rather than substitutes.

In recent years there have been many monetary innovations in Israel. The new developments have not yet been explained—fully or in part—by a theoretical model, and construction of such a model encounters many difficulties. Much depends on future research. In the present state of the art, we can resort to the second approach, in an attempt to discover the empirical regularities of the interactions between money and prices, so as to indicate the direction of theoretical research. The present study relies mainly on time-series analysis.

[2] Our maintained hypothesis derives from the theory (Granger and Newbold, 1977).

The principal criterion by which an econometric time-series study is to be judged is of course the predictive power of its equations. In the last ten years a literature has grown up on this topic under the label of causality, a concept that is interpreted as follows: if a variable X gives a prediction of variable Y which is better than one using information U, from which X has been excluded, X is said to cause Y.[3] Define $\sigma^2(Y \mid U)$ as the variance of the forecast error of Y, conditional on information U. Then X causes Y if

$$\sigma^2(Y \mid U) < \sigma^2(Y \mid U - X), \tag{1}$$

where $U - X$ is information U *less* series X. This is Granger's (1969) definition of causality. Clearly, causality may run both ways, and in that case

$$\begin{aligned} \sigma^2(Y \mid U) &< \sigma^2(Y \mid U - X) \\ \sigma^2(X \mid U) &< \sigma^2(X \mid U - Y). \end{aligned} \tag{2}$$

This meaning of causality is identical with neither the philosophical meaning[4] nor the everyday definition.

As an example, take an economy in which, by assumption, inflation is due solely to monetary factors, that is to say, an economy in which changes in the quantity of money cause (in the dictionary sense) changes in inflation. If in a given year economic agents expect a significant increase in the quantity of money in the next year, it is reasonable to assume that this expectation will raise prices in the current year, that is, before any increase has occurred in the money stock; the next year, the money stock does rise, as expected. The econometrician carrying out a causality test for this economy will get an unequivocal result—the increase in the quantity of money is Granger-caused by the price increase, whereas, on our assumption, the opposite is true. Thus when expectations play a dominant part in the system of variables analysed (e.g. stock-exchange variables), causality tests may give a misleading picture of the causal relationship (in the ordinary sense). If, however, the tests indicate the direction of (statistical) causality, any model constructed must be consistent with the test result.

The most important practical problem in defining causality is the choice of U and the choice of predictive model. Granger recommends concentrating on two series, X and Y, to include the lags of both in U, and to make do with linear predictions. Under these contraints, Granger's test is a simple F test of the significance of a group of variables that includes the 'causal' series, with several lags:

$$Y_t = \alpha_1 Y_{t-1} + \alpha_2 Y_{t-2} + \cdots + \alpha_n Y_{t-n} + \varepsilon_t \tag{3}$$

$$Y_t = \beta_1 Y_{t-1} + \beta_2 Y_{t-2} + \cdots + \beta_n Y_{t-n} + \gamma_1 X_{t-1} + \cdots + \gamma_n X_{t-n} + \delta_t. \tag{4}$$

[3] Information U contains all current and past data on Y and any other series likely to help in the prediction of Y, including series X.

[4] In the philosophical sense, there is a causal relationship between two factors if a change in one is a necessary condition of a change in the other.

The test is

$$\begin{aligned} &H_0: (\gamma_1, \gamma_2, \ldots, \gamma_n) = 0 \\ &H_1: \text{otherwise.} \end{aligned} \tag{5}$$

This test has statistical validity if the random errors ε_t and δ_t in (3)–(4) are normally distributed without serial correlation.[5] The main difficulty arises because of the possibility that

$$\begin{aligned} &\sigma^2(Y \mid Y, X) < \sigma^2(Y \mid Y) \\ &\sigma^2(Y \mid X, Y, Z) \not< \sigma^2(Y \mid Y, Z) < \sigma^2(Y \mid Y); \end{aligned} \tag{6}$$

in other words, if there is a third variable which is the cause of Y, its omission can lead to erroneous conclusions.

In his seminal 1972 paper Sims developed a causality test based on a significance test for leads. By the Sims test, Y formally causes X if $(\beta_1, \beta_2, \ldots, \beta_m) = 0$ in

$$Y_t = \sum_{i=0}^{n} \alpha_i X_{t-i} + \sum_{j=1}^{m} \beta_j X_{t+j} + \varepsilon_t. \tag{7}$$

We chose to use Granger's rather than Sims' test, for two reasons: (a) The Sims test has statistical validity only if the X and Y series have been transformed into a stationary series by filtering (Sims 1972, p. 545). The test is sensitive to the choice of filter, a choice that is controversial.[6] The Granger test is preferable from this point of view since it uses the crude series (a feature that also improves one's intuitive understanding of the results), and increases the validity of the test. (b) Sims himself has proved that if the assumptions underlying his test hold, the two tests are identical. For reasons of convenience, we decided to work with the Granger test. We should add that Sims shows that tests of causality are in general tests of statistical exogeneity, and it is chiefly this that makes the Sims test important. To illustrate: if

$$Y_t = \sum_{i=-k}^{n} \beta_i X_{t-i} + \varepsilon_t \tag{8}$$

(where k is the expected length of lag) and the Sims test rejects the hypothesis $H_0: \beta_{-k} = \cdots = \beta_0 = 0$, the estimates obtained from regression (9) will be biased and inconsistent as a result of the omission of variables correlated with the explanatory variables of this regression:[7]

$$Y_t = \sum_{i=1}^{n} \beta_i X_{t-i} + \delta_t. \tag{9}$$

[5] The F test, which tests for serial correlation of order n, failed to reject the null hypothesis (no serial correlation) in all equations.

[6] See Schwert (1977), Auerbach and Rutner (1978), and Zellner (1979).

[7] This correlation is due to the strong serial correlation found in all macroeconomic series. As can be seen in (9), $\delta_t = \Sigma_{i=-k}^{0} \beta_i X_{t-i} + \varepsilon_t$.

The conclusion is that the Sims model, as formulated in (9), produces consistent estimates if and only if there is neither Granger nor Sims causality from Y to X.

Some time-series exhibit seasonality. If it is assumed that both X and Y do so, the question arises whether they should be deseasonalized. If the seasonality of Y is Granger-caused by the seasonality of X, a test on deseasonalized data biases the conclusions. However, this is not very likely, since the relationship will hold regardless of seasonal factors if X causes Y. In that case the test will probably not be sensitive to deseasonalization. If, on the other hand, it is assumed that series X is seasonal while the series Y is not, failure to deseasonalize X (when it is the dependent variable) is liable to give spurious significance to Y. When Y is the dependent variable, this problem does not arise.

We carried out all tests with and without deseasonalizing. The price data are strongly seasonal (rising at the time of the festivals—October, November, April, May), while the monetary data are not. The data were deseasonalized by introducing a dummy variable for each month as an additional explanatory variable; most of the findings were not sensitive to this procedure. When the findings are reversed, the matter must be investigated further.

The literature on the choice of lag is scanty, and it is usual to try out different lags in order to discover regularities in the data. It is customary to use the same lags for X and Y, a convention that has no theoretical justification; however, there are far too many possible lag combinations for it to be feasible to estimate them all. We too follow the conventional course: if it is assumed that an increase in the money stock affects prices with a lag of years, we can reject the hypothesis that money causes inflation in the short run, and it can be argued that money does not affect prices beyond the effect of lagged prices on prices. At the same time, the price increase can be explained by an increase in the quantity of money in the less recent past.

In practice this can be tested by

$$Y_t = \sum_{i=1}^{n} \alpha_i Y_{t-i} + \sum_{j=1}^{m} \beta_j X_{t-k-j} + \varepsilon_t. \qquad (10)$$

The test here is the one used earlier for

$$H_0:\ \beta_1 = \cdots = \beta_k = 0$$
$$H_1:\ \text{otherwise.}$$

We tried a few experiments on these lines. The results were not satisfactory, but we believe that this line of investigation is worth pursuing.

3. A BRIEF SURVEY OF RELATED RESEARCH

An econometric study connected with our topic was carried out by Kleiman and Ophir (1972 and 1975) for the economy of Israel for 1955–65. This study showed that in Israel, inflation affects the quantity of money; this could, for example, be due to the government's efforts to maintain a constant real deficit. In order to do this, the government creates means of payment against each increase in the rate of inflation. Similarly, if the central bank's policy is in accordance with the real-bills doctrine, it will inject liquid assets into the system with each increase in the rate of inflation.

Another related study is Blejer and Leiderman (1980), which examines some monetary aspects of Israel's inflation in 1977–79. The authors apply causality tests to the connection between inflation and three definitions of money and find that M_3 is the only monetary variable to give a significant explanation of monthly changes in the rate of inflation (M_3 is the definition of money that includes deposits denominated in foreign currency).

Several studies on similar topics and using similar tools have been carried out in the U.S. economy. Feige and Pearce (1979) examine the contribution to the explanation of inflation of lags in the quantity of money, and they also take inflation lags into account. They found that in order to forecast inflation from quarterly data it is sufficient to look at past inflation rates—monetary (and fiscal) variables do not make a significant contribution to the explanation. Sims (1972) and Williams et al. (1976) obtained similar results for the United Kingdom. Brillembourg and Khan (1979), who used annual data covering about 100 years, reached entirely different conclusions in their investigation of similar questions in the United States; they found that the quantity of money affects the rate of inflation with a 2-year lag, the effect being significant. Thus studies in the United States have found a long-run but not a short or medium run effect of money on inflation. These results accord with the view that in the short run prices are fairly inelastic with respect to monetary changes, and that this rigidity tends to disappear in the longer run.

Other studies have investigated the European hyperinflations, particularly those of the 1920s (see for example Sargent and Wallace, 1973, and Frenkel, 1977). Here, a clear effect of inflation on money is found, the reverse effect being absent. This result is similar to that of Kleiman and Ophir (1972) for Israel, and it appears to be due to the efforts of governments to maintain a constant real deficit.

The studies so far cited use causality tests. Among those using more structural models of the economy of Israel, Artstein and Sussman (1978) found that the growth rate of the quantity of money in the conventional definition has a significant but quite small effect on the rate of inflation.

4. THE FINDINGS

As mentioned, we examine the interactions between inflation and money, using monthly, quarterly, and annual data for the short (3 to 6 months lag), medium (2 to 4 quarters), and long run (1 to 2 years) interactions, respectively. The monthly data are divided into two subperiods with the break at the 1977 foreign currency reform. Results referred to as significant are significant at 5 percent unless otherwise stated.

The Effect of Monetary Variables on Inflation

The short run

Before the reform: The results are presented in panel I of Table A-1. As can be seen, the only monetary variable to show significant Granger causality from money to inflation is M_4, whose coefficient has an F exceeding the critical value in all regressions in which it is lagged from 3 to 6 months. All other coefficients of the monetary variables are nonsignificant, with that of credit, C_0, the only one for which F approaches the critical value.

After the reform: The results are shown in the lower part of panel I of Table A-1. Again, most of the explanatory variables have nonsignificant coefficients. The exceptions are C_0, whose coefficient is significant in the 3-month and 4-month lag equations; and M_4, with a significant coefficient only with the 4-month lag (elsewhere it is on the borderline of significance).

The medium run

The results are shown in panel II of Table A-2. As can be seen, no causality from M to P is found.[8]

The long run

The F test was applied to M_1 for 1954–79 (Table A-3). The F value is significant at 10 percent only with the 2-year lag.

The Effect of Inflation on the Monetary Variables

The short run

Before the reform: Table A-1, panel II, shows the F statistic for the null hypothesis that inflation does not affect money. The results are unambiguous: inflation does not affect money, however defined, all F statistics being well below the critical value. These results hold also when the data are deseasonalized by dummy variables.

After the reform: The results are shown in the lower part of Table A-1, panel II: (a) M_3 and M_4, which contain inflation-linked elements, are strongly affected by inflation, in all equations and for all lags tested; (b) the credit variable, C_0, is significantly affected only with the 3-month lag; the effect weakens with longer lags and becomes nonsignificant; and (c) none of the other monetary variables are affected by inflation.

[8] The F statistic for G_1 (injection due to the government's demand surplus) verges on significance with a 2-quarter lag, but is definitely nonsignificant with the 4-quarter lag.

The medium run

The results are shown in Table A-2, panel II: (a) the effect of inflation on M_1, M_2, G_0, and G_1 is highly significant; (b) the F statistics for M_3 and M_4 are nonsignificant at all lags; (c) credit and the narrowly defined money base (C_0, B_1) are significantly affected by inflation with the 2-quarter lag; with 4 quarters, the effect is not significant.

The long run

Again only M_1 was tested (Table A-3). The F statistic is well above the critical value and the null hypothesis is thus rejected. That is, inflation affects M_1 in the long run.

5. CONCLUDING REMARKS

This study has presented a method of using econometric tests to investigate the causal relations between monetary variables and inflation, in the short, medium, and long runs. We found that in Israel the relationship runs both ways—there is no dominant unidirectional causality.

The interactions are unstable over time; the economic reasons for this should be investigated and an attempt made to incorporate them explicitly in a structural model.[9] One factor which might cause the interactions to vary between runs is the public's adjustment of its portfolio to inflation. The ease of varying the portfolio may also affect inflation itself.

We also found that the dynamics of the interaction change over time—for example, results that apply to the short run are not always applicable to the medium or long run. The choice of horizon is therefore a central issue for any study in this field.

These results strongly suggest that there is a need to study the structure of the mechanisms of the effect of money on inflation and vice versa. Consider, for example, the significant effect of inflation on money. Two alternative mechanisms are possible: (a) some of the important monetary aggregates contain linked assets, which are automatically revalued by any price change; or (b) changes in the rate of inflation are often accompanied by monetary changes arising from other causes, such as the government's attempt to finance a given real deficit by printing money; monetary accommodation of the central bank; or the external sector's reaction to changes in the rate of inflation and its effects on the money base; and so forth. An important question here is how much of the causality stems from (a) and how much from (b).

Finally, an important conclusion emerges from this study on the construction of a structural model: since the interactions found operate in both directions and there is no dominant direction of causality, it follows that in the Israeli economy money and inflation are endogenous to the macroeconomic system.

[9] In order to investigate the instability found, long time series should be used.

Table A-1

GRANGER CAUSALITY TEST OF THE SHORT-RUN INTERACTION OF MONEY ON PRICES (MONTHLY DATA)*

(F values)

Lag, months	M_1	M_2	M_3	M_4	G_0	G_1	B_1	C_0	Critical F value
I. The effect of money on prices									
Pre-reform (1/1972–10/1977)									
Seasonally adjusted									
1–3	0.80	0.76	0.52	3.13*	1.88	0.82	3.14*	2.72	2.80
1–4	0.66	0.99	1.05	3.10*	1.50	1.48	2.03	2.38	2.57
1–5	0.58	0.87	0.81	2.98*	1.11	1.09	1.84	1.81	2.44
1–6	0.53	0.80	0.70	2.42*	0.86	0.88	1.52	1.79	2.35
Unadjusted									
1–3	0.08	0.18	0.36	3.94*	1.00	1.43	1.93	2.08	2.76
1–4	0.14	0.45	0.52	3.50*	0.72	1.22	1.44	1.61	2.52
1–5	0.13	0.40	0.32	4.52*	0.46	1.05	1.00	1.25	2.39
1–6	0.20	0.48	0.36	3.63*	0.86	1.11	0.95	1.10	2.29
Post-reform (11/1977–9/1980)									
Unadjusted									
1–3	1.30	0.75	2.02	2.57	1.34	1.41	0.47	6.57*	2.96
1–4	1.18	1.09	2.02	3.37*	0.69	0.66	0.95	3.48*	2.76
1–5	0.43	0.35	2.26	2.23	1.33	0.68	1.50	2.12	2.64
1–6	0.38	0.30	2.03	1.76	1.63	1.35	1.54	1.79	2.57
II. The effect of prices on money									
Pre-reform (1/1972–10/1977)									
Seasonally adjusted									
1–3	0.63	0.46	0.60	1.11	0.56	0.56	0.65	0.58	2.80
1–4	1.12	1.08	0.40	0.66	0.73	0.47	1.13	0.87	2.57
1–5	0.84	0.79	0.36	0.56	0.60	0.36	0.80	0.51	2.44
1–6	0.80	0.75	0.46	1.18	0.74	0.36	1.16	0.40	2.35
Unadjusted									
1–3	0.60	0.61	0.35	0.85	0.97	1.12	1.77	0.73	2.76
1–4	0.54	0.66	0.35	0.63	0.85	0.84	1.59	0.66	2.52
1–5	0.41	0.47	0.31	0.60	0.86	0.85	1.28	0.51	2.39
1–6	0.34	0.40	0.24	1.37	1.40	0.70	1.60	0.66	2.29
Post-reform (11/1977–9/1980)									
Unadjusted									
1–3	1.07	1.38	4.52*	3.55*	2.37	0.99	0.76	3.01*	2.96
1–4	1.49	1.33	3.74*	4.31*	2.74	1.42	0.94	2.43	2.76
1–5	1.11	1.23	3.85*	3.74*	2.03	1.03	0.76	1.79	2.64
1–6	1.45	1.89	4.05*	2.93*	1.81	0.98	0.57	2.38	2.57

* Asterisk denotes significant at 5 percent.

Table A-2

GRANGER CAUSALITY TEST OF THE MEDIUM-RUN INTERACTION OF MONEY AND PRICES (QUARTERLY DATA): I/1972–III/1980

(F values)

Lag, quarters	M_1	M_2	M_3	M_4	G_0	G_1	B_1	C_0	Critical F value
I. The effect of money on prices									
1–2	0.20	0.19	0.25	0.98	0.40	3.00	0.17	0.54	3.35
1–4	0.17	0.32	0.50	0.40	0.55	0.48	0.35	0.20	2.76
II. The effect of prices on money									
1–2	4.68*	7.50*	2.25	1.45	8.03*	3.25*	3.48*	3.17	3.35
1–4	3.19*	3.06*	0.78	0.77	3.35*	3.90*	1.32	0.53	2.76

* Asterisk denotes significant at 5 percent.

Table A-3

GRANGER CAUSALITY TEST OF THE LONG-RUN INTERACTION OF M_1 AND PRICES (ANNUAL DATA): 1954–79*

(F values)

	I. The effect of M_1 on prices		II. The effect of prices on M_1	
Lag, years	M_1	Critical F value	M_1	Critical F value
1	1.63	2.96	9.26**	4.32
1–2	3.04*	2.62	5.37**	3.55

* Significant at 10 percent, *, and at 5 percent, **

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